Course Type	Course Code	Name of Course	L	T	P	Credit
DE	NMED512	Microfluidics	3	0	0	3

Course Objectives

Prerequisite: Basic knowledge of fluid mechanics is essential

Microfluidics is an emerging and rapidly growing technology. The concept is widely applied to thermal management; MEMS based instruments and biological devices. In this course, students will learn principles of micro- and nano-scale transport phenomena. In addition, the course will also discuss about the micro-fabrication and few components of micro-system with some application.

Learning Outcomes

Upon successful completion of this course, students will:

- have a broad understanding of microfluidics and its application.
- have analytical and mathematical tools to handle microfluidics problem.
- be able to understand the fabrication technique for making microfluidics devices.

Modules	Topics	Lecture hours	Learning outcomes
1	Introduction to microfluidics; Scaling analysis, Theory of microscale fluid flow: Intermolecular forces, States of matter, Continuum assumption	5L	Students will learn about the basics of microfluidics and its comparison with macro level fluid mechanics
2	Governing equations, Constitutive relations. Gas and liquid flows, Boundary conditions, Slip theory, Transition to turbulence, Low Re flows, Entrance effects. Exact solutions, Couette flow, Poiseuille flow, Stokes drag on a sphere, Time-dependent flows, Two-phase flows, Thermal transfer in microchannels. Hydraulic resistance and Circuit analysis, Straight channel of different cross-sections, Channels in series and parallel	10L	They will learn the basic fluids mechanics and mathematic used for the analysis of microfluidics.
3.	Electrohydrodynamics-Electrophoresis. Electro osmosis, Electrical double layer,	8L	Student will learn about the flow and particle separation using Electrohydrodynamics
4.	Surface tension driven flow-The Young–Laplace pressure, Contact angle, Capillary Pump, Marangoni effect; surface-tension gradients	8L	Student will learn about the surface driven flow in microchannel.
5.	**Diffusion and Mixing-**Physics of mixing, The H filter, Shortening diffusion length scale, Laminar flow patterning, Taylor Aris dispersion	5L	Student will learn about diffusion and mixing in microfluidics devices.
6	Micro fabrication: Fabrication techniques for microdevices: photolithography, silicon-based	4L	Students will learn about the different fabrication techniques for

	micromachining, polymer-based micromachining		microfluidics devices
7	Few applications of microfluidics: Drug delivery, Diagnostics, Bio-sensing	2L	Recent applications of microfluidics for bio application will be discussed

Total = 42 hrs

Text Books

1. HENRIK BRUUS, Theoretical Microfluidics, Oxford University Press Inc.

Reference books

1. Nguyen, N. T., Werely, S. T., Fundamentals and applications of Microfluidics, Artech House; 3rd Edition (January 31, 2019).
2. Tabeling, P., Introduction to microfluidics, Oxford University Press Inc.
3. Kirby, B. J., Micro- and Nanoscale Fluid Mechanics: Transport in Microfluidic Devices.
4. Kleinstreuer C., Modern Fluid Dynamics, Springer
5. Madou, M. J., Fundamentals of Microfabrication, CRC press.